SUBJECT: INSTRUMENT OPERATION:

QUESTemp° II Personal Heat Stress Monitor

Contents

1.0 Purpose/Scope

This procedure provides a standardized method for the operation of the QUESTemp° II. *Personal Temperature Monitor*.

The QUESTemp° II personal heat stress monitor tracks an individual's body temperature for indications of the onset of heat stress. It warns the user when their personal body temperature has risen above the "safe" level and that action should be taken to allow the body to cool. The data is logged so that a record of body temperature can be preserved.

This dosimeter is used in work situations when site and area monitoring do not represent an accurate measurement of worker exposure. This is true when workers wear personal protective equipment that inhibits body cooling or when workers conduct operations that are not represented by area measurements. The QUESTemp° II logs 10 second averages of the aural temperature throughout the monitoring period.

2.0 Responsibilities

2.1 Use of the QUESTemp° II shall be limited to individuals who act under the direction of

a competent hazard assessment person and have demonstrated the competency to satisfactorily use the meter, as evidenced by experience and training, to the satisfaction of the qualification criteria set by SHSD.

2.2 Personnel that perform exposure monitoring with this instrument are responsible to follow all steps in this procedure.

2.3 The data collected using this meter must have an appropriate evaluation of the hazard and risk by a cognizant Industrial Hygiene professional.

3.0 Definitions

3.1 *Acclimated Worker:* physiological adoptions that improve performance in heat that occurs typically after 3 weeks of continued physical activity under heat stress conditions similar to those in the anticipated work. Acclimatization begins to be lost after 4 days of discontinued work.

3.2 *Heat Stress* is the net heat load to which a worker may be exposed from the combined contributions of metabolic, cost of work, environmental factors (i.e. air temperature, humidity, air movement and radiant heat exchange) and clothing requirements.

3.3 *Occupational Exposure Limit (OEL):* Heat stress is typically regulated in the workplace with regard to either the WBGT index (Wet Bulb Globe Temperature) or the individual's body indicators (core temperature & heart rate). BNL uses the ACGIH screening criteria for heat stress exposure to determine work/rest regimens under normal operations and core body temperature or heart rate when water-vapor-impermeable, air-impermeable or thermally insulating work clothes are worn.

3.4 *Wet Bulb Globe Temperature (WBGT) Index:* A first order index of the environmental contribution to heat stress. Used as screening criteria regulating the work/rest regimen for various levels of the index. This is based on the air temperature, radiant heat, and humidity.

4.0 Prerequisites

Training prior to using this meter: See Section 7 for qualification requirements.

5.0 Precautions

5.1 **Hazard Determination:** The operation of this meter does not cause exposure to any chemical, physical, or radiological hazards. The meter design does not cause significant ergonomic concerns in routine use. The meter does not generate Hazardous Waste or environmental impact.

5.2 **Personal Protective Equipment:** No PPE is needed to operate this equipment. Check with the FS Representative for the area being entered.

5.3 **Dosimeter Calibration:** Failure to calibrate the QUESTemp° II prior to use may result in an increased margin of error in the results. All field testers must validate the calibration status in accordance with Section 6.0 before each use and when the workers environmental temperature changes more than 10^{o}C. .

6.0 Procedure

6.1 **Equipment:** (Pictured in Attachment 9.1)

- 6.1.1 Meter Body with a thin flexible cable leading to a small ear mold.
- 6.1.2 Disposable E.A.R® foam earplug.
- 6.1.3 Replacement ear loops.
- 6.1.4 Oral temperature probe w/ disposable sheaths.
- 6.1.5 RS-232 Serial Computer/Printer Interface
- 6.1.6 9V Disposable Battery (60 Hrs. Runtime)

6.2 **Start the QUESTemp° II:** Turn the meter on by pressing: ON/OFF. (See photo of meter and controls in Attachment 9.1.) The internal programming version number is displayed (1.7) until a key is depressed. If the battery is low "LO" appears on the screen.

6.3 **Clear Data from the Memory:** To clear the memory and calibration data, the instrument must be in the ***On*** mode.

- 6.3.1 Press RESET shows 0:03 in the display.

6.3.2 Press and hold the RESET **key** for three seconds as the display counts down from "0:03" to "0:01"then will go blank.

6.3.3 Release the RESET button will display "rES" The unit is then reset to the factory defaults.

6.4 **Setting up and placing the temperature probe in the worker's ear canal:**

6.4.1 With clean hands, have the worker roll the disposable yellow E.A.R.~ foam ear plug (containing a black protruding tube) back and forth with the fingers until it forms a small crease-free cylinder.

6.4.2 Using only light pressure to keep the E.A.R.~ plug rolled tight, gently slide the plug over the temperature sensor of the earmold assembly. The black tube should slide into the earmold leaving only the yellow foam plug visible. The sensor should fill the black tube of the E.A.R.~ plug with the tip lying flush with, or just inside of, the outer end of the tube.

6.4.3 With the E.A.R.~ plug still rolled tight, have the worker hold on to the blue earmold and quickly insert the rolled up plug into the ear canal and hold it in place until it expands. [Discontinue inserting the plug if pain occurs.] The yellow portion of the earplug should be completely contained within the ear canal without any danger of hurting the inner ear. Fitting is easier if the outer ear is pulled outward and upwards during insertion. If the initial fit is inadequate, remove the plug and repeat the process.

6.4.4 Allow 6 – 10 minutes for it to stabilize to the correct temperature.

6.5 **Taking the oral temperature:** Collect and log oral core temperature of the worker utilizing either:

- The QuestempII Oral temperature probe (if provided) with disposable hygiene sheaths. (Attach to the "Cal" connector on the front of the meter.
- An external oral thermometer.

When taking an oral temperature, the person should be rested and should not have had anything to eat or drink in the past 15 minutes. The probe should be kept under the tongue with the mouth closed. Record the temperature in degrees Celcius.

6.6 **Entering the workers oral temperature into the meter:** This procedure utilizes the oral thermometer reading from Step 6.5.

6.6.1 Pressing CAL once will display '0---'.

6.6.2 Pressing CAL a second time will blink '36.0' representing the core temperature. Adjust this value between 36.0 and 39.0 by pressing the (ARROW) ⇒ key until it displays the core temperature collected from the Oral temperature probe.

6.6.3 Then press ENTER to complete the calibration sequence. 'CAL' will momentarily appear in the display to indicate the CORE temperature minus the EAR temperature value was obtained and is added as an offset to the EAR temperature.

6.7 **Set the alarm level:** The alarm sounds automatically when the set point is reached. A secondary alarm is set as 0.5°C above the alarm set point. The alarm level should be adjusted based on the oral temperature using the formula:

(Oral Temperature°C + 2°C)

but should not be set to exceed: **38°C** for non-acclimated workers and
39°C for acclimated workers.

Example: A worker's oral temperature is 36.4C. 36.4C + 2C = 38.4C. Set the alarm for 38.0C for an unacclimitized worker and 38.4C for an acclimated worker.

The alarm level may be changed only if the memory is clear, prior to logging data. Once run time has accumulated, the unit must be reset to change the alarm level setting. To view/change the alarm level:

6.7.1 Press ALARM LEVEL to display the current alarm level setting.

6.7.2 Press ALARM LEVEL and (ARROW) ⇒ simultaneously and hold for three seconds. The displayed level will flash and can be altered between 38°C and 39°C using the (ARROW) ⇒ key.

6.7.3 Set the alarm level using the (ARROW) ⇒ key.

6.7.4 Press ENTER when you have reached the appropriate alarm level.

6.8 **Advise workers of the alarms,** and that they must exit the area if the alarm sounds. The AUDIBLE ALARM sounds in the speaker located in the ear assembly under three conditions:

- The When the 10-second-average temperature in the ear canal exceeds the set alarm level (two pulses every second).

- When the 10-second-average temperature in the ear canal exceeds O.5 °C above the set alarm level (four pulses every second).
- When the battery voltage falls below 7.2 volts, continuous warning. The unit has stopped reading temperature data. Replace the battery immediately.

6.9 **Start Logging:** When work is ready to begin,

6.9.1 Press RUN to begin operating and collecting data.

6.9.2 Clip the meter to belt or place in a coat, suit, or pant's pocket.

6.10 **Ending Logging:** When monitoring is completed, turn off the unit by holding the ON/OFF key for three seconds. Data will be saved in the unit.

6.11 **Recording separate events:** You can separate the logging into "events" (such as before and after breaks for lunch) by turning the unit off. Shut down the unit by pressing and holding the ON/OFF key for three seconds. This will shut down the instrument for events such as leaving for lunch. Turn the unit on by pressing ON/OFF key, then press RUN again to begin a new event upon return to work.

6.12 Discard the yellow ear plug:

- Between workers
- At the end of the day or
- If the plug becomes soiled.

6.13 **Documenting Sampling Data and Work Conditions readings:**

6.13.1 Recorded data may be printed directly to a serial printer or downloaded to a computer. (See attachment 9.3)

6.13.2 Provide a copy of the printed data, to the SHSD IH Laboratory Technician.

6.13.3 Notify the monitored employee of results.

6.14 **Results interpretation**:

6.14.1 Data reports are to be reviewed by the cognizant IH professional to determine adequacy of controls, actions taken and corrective actions as needed.

6.14.2 Ensure that a copy of the hazard evaluation report is sent to the IH Laboratory and is included in the ESHQ Directorate Recordkeeping system.

6.14.3 Ensure that a copy of the written hazard evaluation report is sent to the Occupational Medicine Clinic with the worker's BNL Life Number noted.

7.0 Implementation & Training

Prior to using this meter, the operator of the meter:

7.1 Appropriate training for areas to be entered (check with ESH coordinator or FS representative for the facility).

7.2 Qualification in the hazards of heat stress as per the SBMS Subject Area *Natural Hazards in the Environment* and the BTMS Web Based class on heat stress.

7.3 Qualification on the meter described this procedure:
- 7.3.1 Personnel are to document their training using the Attachment 9.6 with its *Job Performance Measure Completion Certificate* for this meter.
- 7.3.2 Qualification on this JPM is required on a 3 year basis, providing the professional is monitoring noise sources frequently.

8.0 References

8.1 Quest QUESTemp° II Instruction Manual 56-025 Rev. D 2/00
8.2 BNL Subject Area Natural Hazards in the Environment
8.3 ACGIH American Conference of Governmental Industrial Hygienists Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices.

9.0 Attachments

9.1 QUESTemp° II meter photo

9.2 Control Keys
9.3 Printing or Downloading Stored Data
9.4 Example of a Print-out from the meter

9.5 Signs, Symptoms and Response Actions for Heat Stress Illnesses
9.6 Personnel Qualification Record Form

10.0 Documentation

Document Development and Revision Control Tracking		
PREPARED BY: *(Signature and date on file)* **E. Lacina** **Author** **Date 07/30/04**	**REVIEWED BY:** *(Signature and date on file)* **J. Peters** **SHSD IH Group** **Date 7/30/04**	**APPROVED BY:** *(Signature and date on file)* **R. Selvey** **SHSD IH Group Leader** **Date 09/08/04**
ESH Coordinator/ Date: *none*	Work Coordinator/ Date: *none*	SHSD Manager / Date *none*
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ISM Review - Hazard Categorization ☐ High ☒ Moderate ☐ Low/Skill of the craft	Validation: ☐ Formal Walkthrough ☐ Desk Top Review ☐ SME Review Name / Date:	Implementation: Training Completed: Tracked in BTMS Procedure posted on Web:07/07/06 Hard Copy files updated: 07/07/06

Revision Log		
Purpose: ☐ Temporary Change ☐ Change in Scope ☐ Periodic review ☒ Clarify/enhance procedural controls Changed resulting from: ☐ Environmental impacts ☐ Federal, State and/or Local requirements ☐ Corrective/preventive actions to non-conformances ☒ none of the above Resulting from SHSD JRA-15 discussion on hazard controls. Section/page and Description of change: Minor changes to Section 4 and 7 to reflect current qualification process. Text changes to 6.4 to indicate the worker should insert the plug into the ear not the sampling SME. Revised the format of Section 10 to the most recent format.		
(signature on file) ***R. Selvey 07/07/06*** SME Reviewer/Date:	Reviewer/Date:	Reviewer/Date:

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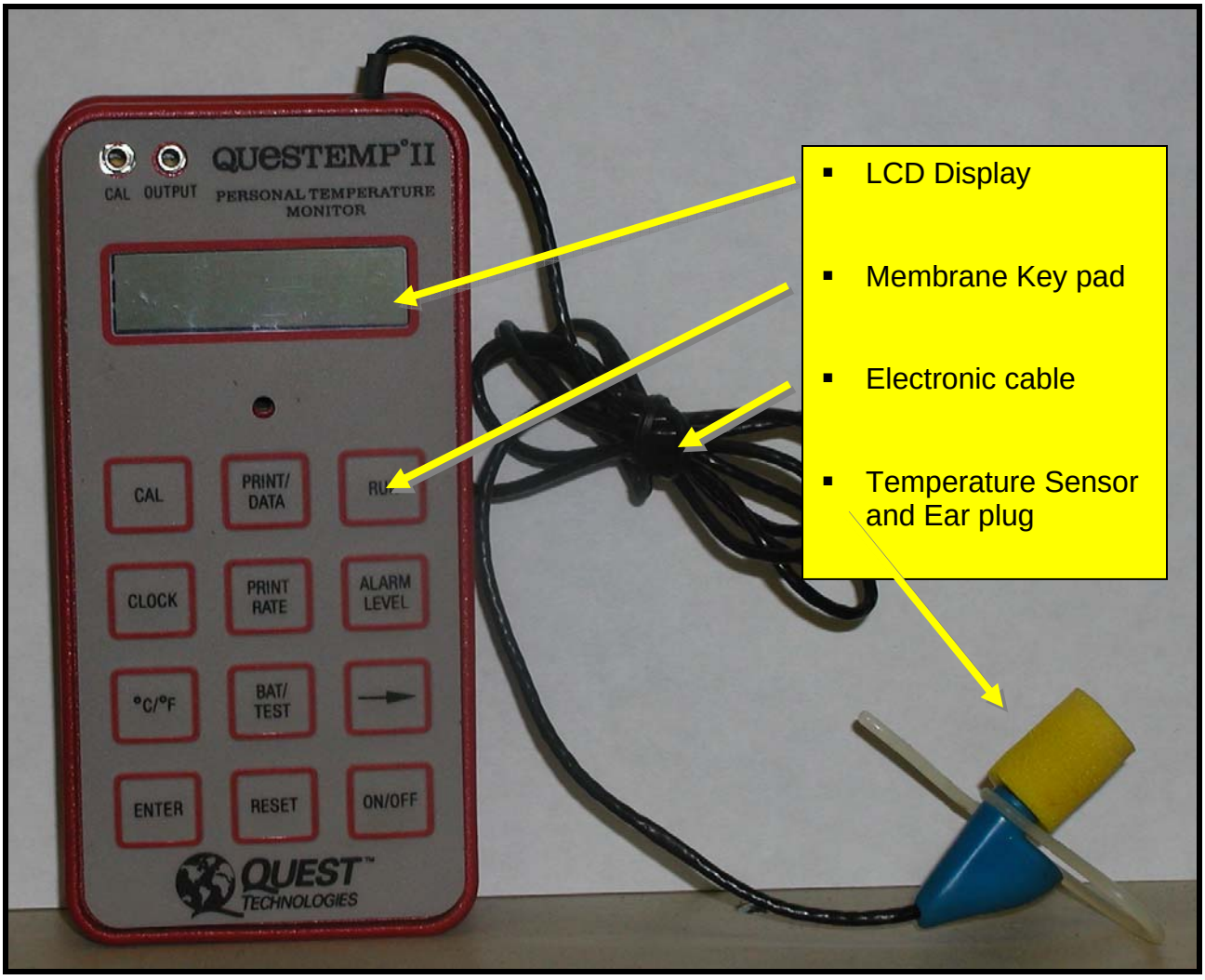
Attachment 9.1

QUESTemp° II Meter Photo



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Attachment 9.2

Control Keys

Control Keys	
CAL	If an oral thermometer is plugged into to the CAL jack, then the oral temperature will be displayed and updated. If the thermometer is not plugged in or if the temperature is below 29.5°C then "0- __II will be displayed. Pressing CAL a second time will display the value of 'ORAL minus EAR' if the thermometer is in place. Otherwise, it will display a temperature, which can be adjusted by pressing the ARROW key, to represent an oral (or core) temperature. In either case, pressing ENTER will store the calibration data. See the section on CALIBRATION for more details.
PRINT/ DATA	The default baud rate will appear in the display. If the ENTER key is pressed then serial ASCII RS232-formatted data will be sent from the output jack and 'prn' will appear in the display. If the PRINT/DATA key is pressed a second time, the displayed baud rate will blink indicating that a new rate may be selected with the ARROW and ENTER keys. The baud rate options are 300, 600, 1200, 2400, 4800, and 9600 baud. After pressing ENTER
RUN	The ear temperature will be displayed and the unit will begin to log the ear (aural) temperature at 10 second intervals along with temperature of the second sensor located within the blue earmold. If there is a thermometer plugged into the CAL jack and its temperature is in the range between 30.C and 42.C, then its value will also be logged. All data will be time averaged from 2 second samples. While the instrument is in the RUN mode, a small arrow will be displayed in the upper left corner of the display. Turn the unit OFF to exit the RUN mode. In the RUN mode, the audible alarm will be activated if the EAR temperature exceeds the alarm level. Turning the unit OFF or printing will abort the RUN mode. If any of CLOCK, PRINT RATE, PRINT, or CAL keys are pressed while in the RUN mode, the display will show that function's setting but the unit will continue to data log and check the temperature. To return the aural temperature to the display, press the RUN key again.
CLOCK	Shows the current time. Pressing CLOCK a second time will cause the right-most digit of the time to flash and allows the clock time to be changed. Cycle through each digit using the ARROW and ENTER keys (in the same fashion as most digital watches) to change the time. Time is displayed in 24 hour format and is maintained in the unit even when it is turned off. In addition, a lithium battery backup will maintain the time even when the 9 volt battery is removed.
PRINT RATE	Displays the rate at which sampled temperature data will be printed. Pressing PRINT RATE a second time will cause the number in the display to flash and a new rate can be selected using the ARROW and ENTER keys. Selectable rates are: lOsec, 30sec, lmin, 5min, and lOmin. Note that this only affects the quantity of data printed, not the amount of data actually stored in the unit.

Attachment 9.2

Control Keys Continued

ALARM LEVEL	Displays the current alarm level setting. If ALARM LEVEL and ARROW are pressed simultaneously, the displayed level will flash and can be altered between 38°C and 39°C using the ARROW and ENTER keys. The alarm level may be changed only if the memory is clear, prior to logging data. Once run time has accumulated, the unit must be reset to change the alarm level setting. In the RUN mode, the audible alarm will be activated if the EAR temperature exceeds the set alarm level. In addition, a secondary alarm will sound if the temperature exceeds O.5°C above the initial chosen alarm level.
°C/°F	Toggles between Celsius and Fahrenheit while in the RUN mode. Calibration and alarm levels operate in Celsius only.
BAT/ TEST	Shows the battery voltage strength in the display while sounding the audible alarm. The actual battery voltage is displayed until the level falls below 7.5 volts. Below 7.5V "Lo" appears in the display indicating that the battery should be replaced with a new 9V alkaline. The unit will operate for at least 8 hours from the time that "Lo" first appears. Once the battery voltage falls below 7.2 volts the alarm will sound continuously and data logging will cease. If this occurs, turn the unit OFF and replace the battery with a new 9V alkaline.
->	ARROW key used to change a parameter for the following functions: PRINT (baud rate), CLOCK, PRINT RATE, ALARM, and CAL when manually entering the calibration data.
ENTER	Enters a change in parameters when one of the following functions is selected and flashing: PRINT, CLOCK, PRINT RATE, ALARM, or CAL.
RESET	When held down for 3 seconds, it will clear all logged and calibration data. All other unit settings remain unaltered.
ON/OFF	Toggles between ON and OFF. OFF will have a 3 second count down and is used to exit the RUN mode. Note that turning the unit OFF will NOT reset or erase any of the logged data. When the QUESTEMP II is turned ON, the internal programming version number is displayed until a key is depressed.

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Attachment 9.3

Printing or Downloading Stored Data

Printing of Logged Data: All logged information can be sent to a computer or serial printer using an RS232 serial protocol. The amount of data printed is determined by the PRINT RATE key on the QUESTemp° II.

Note that if the unit is in the RUN mode when printing is initiated, the RUN mode will be canceled and data logging will cease.

Printer Cables:
Connect the meter directly to a serial printer using cable #58-847. [A serial printer's input is typically a 25 pin female (holes) connector. Do not use cable #58-847 in conjunction with a computer's printer cable because that connects into the printer's parallel input port. Many printers are parallel only and can not accept data from the QUESTemp° II. For printers that have both serial and parallel inputs, refer to the printer's manual for configuring the serial port.)

Computer Cables:
Connect the meter to a computer using cable #58-867 for a 25 pin serial port. (The standard for a computer's serial port is a 25 pin or a 9 pin male (pins) connector. Do not connect to the computer's printer output port which is a 25 pin female (holes) connector. If you have cable #58-867 but your computer's serial port has only 9 pins, then you may use a 25 to 9 pin converter available at most computer or electronic stores. No other cables should be used.)

Computer Downloading using Windows™:
There is a variety of commercially available software that can easily accept data from the QUESTemp° II. These software packages are usually termed "communications software". Microsoft Windows ™ has a communications program under the ACCESSORIES icon called TERMINAL. Instructions on how to use TERMINAL are located in the Windows ™ manuals.

Using any of these communications programs, the user must select the com (serial) port and the baud rate. The Quest cable must be plugged into the selected com port and the baud rate on the unit must match the rate selected in the software. The PC programs also need the following information in

their setup:

data bits = 8 stop bits = 2 parity = none handshaking (flow control) = hardware

For TERMINAL, the settings are found by first selecting SETTINGS, then COMMUNICATIONS.

- To initiate printing, use the following sequence: with the unit ON, plug the printer cable into the OUTPUT port of the QUESTemp° II. Be sure the desired PRINT RATE is selected (see the key function PRINT RATE).

- Press the PRINT/DATA key. If the default baud rate (speed of data transmission) in the display is not the desired baud rate, press the PRINT/DATA key a second time and use the ARROW key to select a new rate. [If you are downloading to a computer, be sure that it is ready to accept data prior to moving to step 6.5.3)

- Press ENTER and the data will be sent. "Prn" will appear in the display until all of the data has been sent.

- To halt printing, simply press the PRINT/DATA key while "Prn" is still in the display.

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Attachment 9.4

Example of a Print-out from the QUESTemp° II meter.

QUEST ELECTRONICS
QUESTEMP II Personal Temperature Monitor

[7]Serial Number: JU1030001 Software Version Number: 1.1

Name: Date:

Location:

[1]Start Time: 11:34 [2]End Time: 13:32 [3]Total Run Time: 01:58

[4]Alarm Level Setting: 38.0 oC
[5]Print Rate: 1 Min.

[6]High Temperature: 38.1 oC At Time: 13:32
[7]Low Temperature: 36.1 oC At Time: 11:34

[8]CAL in degree C	@ Time
0.4	11:41:20

SAMPLED DATA

Time Hr:Min	[9]Ear Temp. oC	oF	[10]Mold Temp. oC	oF	[11]Oral Temp. oC	oF	[12]Alarm
11:34	36.1	97.0	32.7	90.9			
11:35	36.1	97.0	32.7	90.9			
11:36	36.2	97.2	32.8	91.1			
11:37	36.3	97.4	32.9	91.3			
11:38	36.3	97.4	33.0	91.5			
11:39	36.4	97.5	33.1	91.7	36.7	98.1	
11:40	36.4	97.5	33.1	91.7	36.9	98.5	
11:41	36.4	97.5	32.9	91.3	36.9	98.5	
11:42	36.9	98.4	33.0	91.5			
11:43	36.9	98.4	33.0	91.5			
13:29	37.9	100.2	27.6	81.7			
13:30	37.9	100.2	27.4	81.3			
13:31	38.0	100.4	27.3	81.1			*
13:32	38.1	100.6	27.2	80.9			**

Attachment 9.5

Signs and Symptoms of Heat Stress

Disorder Name	*Signs and symptoms*	*What to do*
Heat Rash (also known as "prickly heat")	• Inflammation of the skin resulting from prolonged exposure to heat and humid air. • Often aggravated by chafing from clothes.	Recovery is by rest in the shade and washing the affected areas in cool water.
Heat Cramps	• Cramps in the extremities (especially legs and hands) or abdomen caused by the depletion of water and salt in the body. • Usually occurs after physical exertion in an extremely hot environment or under conditions that cause profuse sweating and depletion of body fluids and electrolytes.	Recovery is by rest in the shade and drinking fluids with electrolytes (sports type beverages are good).
Heat Exhaustion	• Potentially Serious: Weakness, dizziness, nausea. • A result of the body's inadequate effort to give off excessive heat. Although not an immediate threat to life, if not properly treated and exposure to heat continues, could evolve into heat stroke. • Caused by loss of fluids, Skin: clammy & moist	Recovery with rest in shade & drink w/electrolytes
Heat Stroke	Severe and potentially fatal condition resulting from the failure of the body to regulate its core temperature. • Mental Confusion. • Loss of consciousness. • Convulsions. • Body temperature > 106. • Hot, dry skin. No sweating. • May die unless treated promptly.	True medical emergency requiring immediate transport to a medical facility. Call 2222 or 911 from Lab phone for **immediate transport to a hospital.**

Attachment 9.6

Personnel Qualification Record
Form

(next page)

BROOKHAVEN NATIONAL LABORATORY

IH101600 Attachment 9.6

HP-IHP-101600

Environmental, Safety, Health & Quality Directorate
SHSD Industrial Hygiene

Personal Dosimetry for Heat Stress

Using the *QUESTemp° II* Personal Temperature Monitor

Job Performance Measure (JPM) Completion Certificate

Candidate's Name	Life Number:

	Element of Qualification	Unsatis-factory	Recov-ered	Satisf-actory
	Principles of Heat Stress			
1	Has knowledge of heat stress temperature measurement and the reason for sampling.			
2	Understands the varying methods of heat stress monitoring and when each is appropriate.			
3	Can explain the symptoms of heat stress that may occur in monitored workers			
	Set up of meter			
4	Can demonstrate how to assemble and wear the meter.			
5	Can demonstrate how to calibrate (adjust for body core temperature), set alarm levels and operate the meter.			
6	Can demonstrate how to respond appropriately to alarms and recommend corrective actions			
	Documentation of Monitoring			
7	Demonstrates how to Printout hardcopy of monitoring data			
8	Demonstrates how to Download data to computer			
9	Knows the list of organizations and individuals to receive data reports and timeliness requirements.			

Employee: I accept the responsibility for performing this task as demonstrated within this JPM and the corresponding SOP.

Candidate Signature:	Date:

Evaluator: I certify the candidate has satisfactorily performed each of the above listed steps and is capable of performing the task unsupervised.

Evaluator Signature:	Date: